



Comparison of Cloud Detection (*Cloud Properties and Amounts*) to those from AVHRR, HIRS ISCCP and GLAS

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Outline

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- Comparison of Cloud Amounts
- Comparison of Cloud Top Temperature and Emissivity
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- Future Work

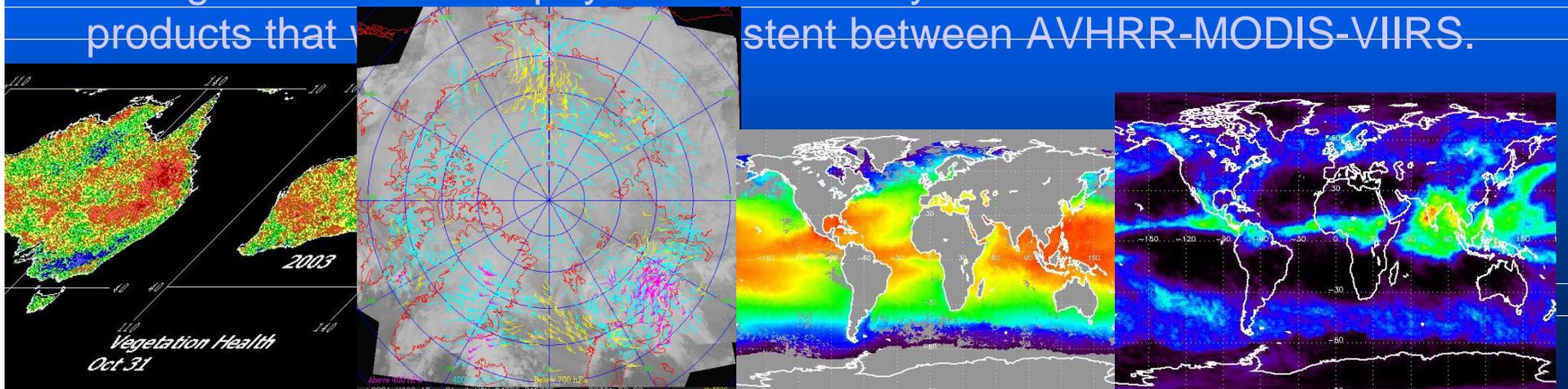
Motivation

- NOAA/NESDIS ORA is reprocessing the entire AVHRR Data Record (1979-2005). AVHRR should exist until 2012.
 - Improving the level 1b data (navigation/calibration)
 - New AVHRR SST, GVI, Polar Winds climatology
 - **PATMOS-x Cloud Climatology**

- With the IPO, we are working on continuity of AVHRR/VIIRS cloud climate records

- MODIS provides an ideal test-bed for developing algorithms and processing strategies that allow for cross-platform continuity

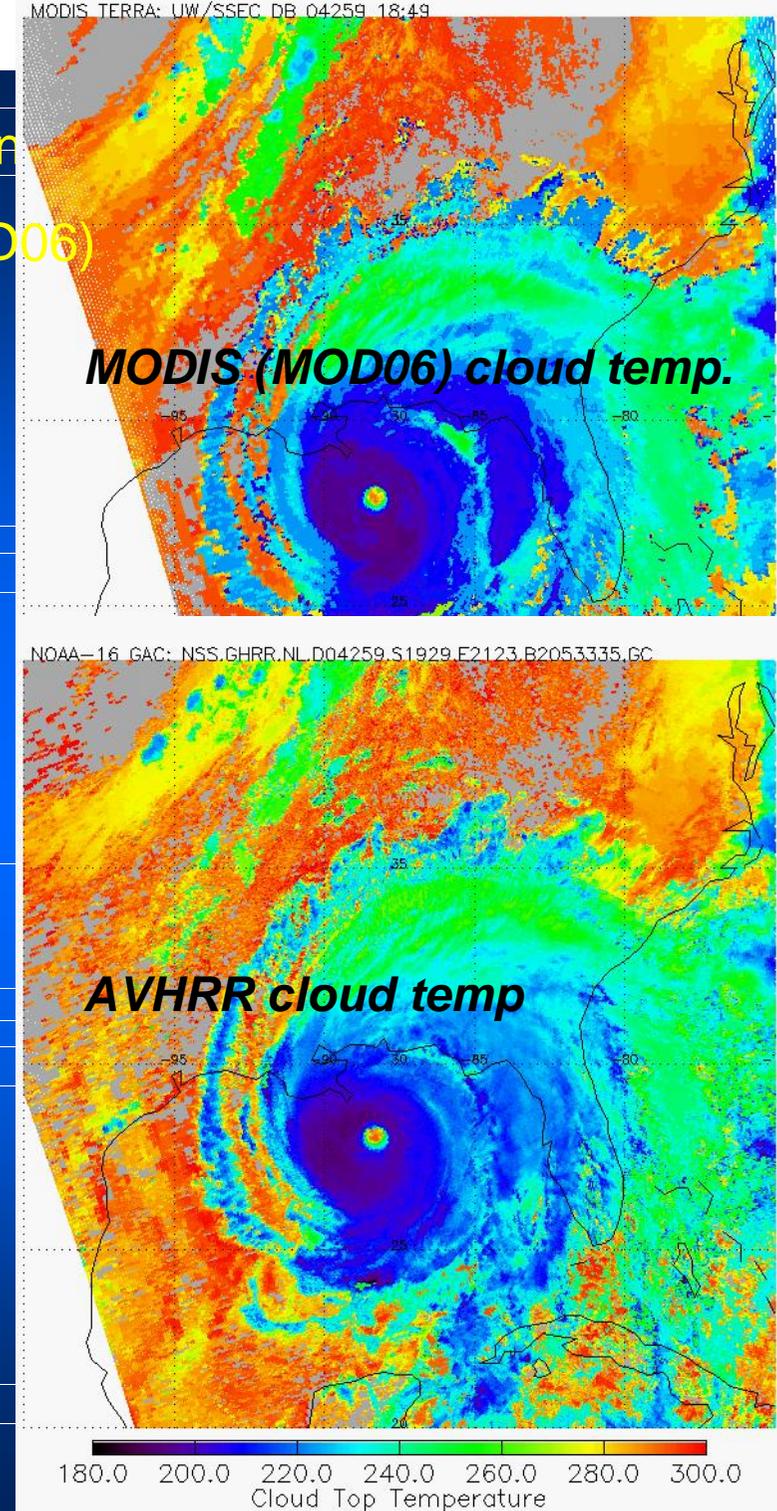
- Our goal is to achieve physical consistency with a few selected cloud products that are consistent between AVHRR-MODIS-VIIRS.



Physical Consistency between AVHRR and MODIS

1. Cloud Top Temperature and Emissivity (MOD06)

- While the AVHRR's spectral resolution and spatial resolution is less from MODIS, we feel several of its key climate records can be made physically consistent with those MODIS for many scenarios.
- For example, we have developed a split window 1d var retrieval approach that derives cloud top temperature and cloud emissivity.
- We have used MOD06 results to guide the development and validation of this approach.
- Figures on the right show a comparison of cloud top temperatures

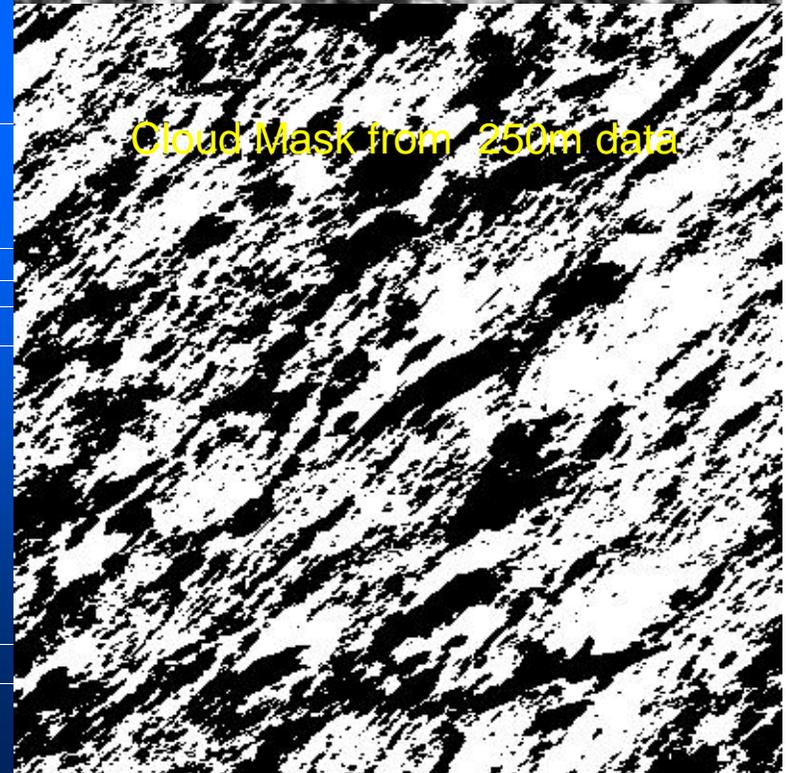


Physical Consistency between AVHRR and MODIS

2. Towards An Objective Cloud Amount

- Different cloud masks assume use different approaches to derive cloud amounts (the cloud coverage over a wide area).
- For example, big uncertainty in CLAVR-x cloud amount is the weighting of non-clear and non-cloudy pixels (*because it has so many of them*).
- The MODIS 250m bands over ideal viewing conditions provide highly accurate cloud/no-cloud results that can be spatially averaged up to any spatial resolution.
- We have used the MODIS 250m results to derive the CLAVR-x weights.
- Our analysis indicates the MODIS 1km mask overestimates the cloud amount relative to the 250 m results by a few %.

100kmx100km image from 250m data



Cloud Mask from 250m data

Physical Consistency between AVHRR and MODIS cloud properties

We feel physical consistency with MODIS can also be achieved for the for the following cloud parameters (outside of polar regions)

- cloud amounts
- cloud optical thickness
- cloud particle size
- cloud phase

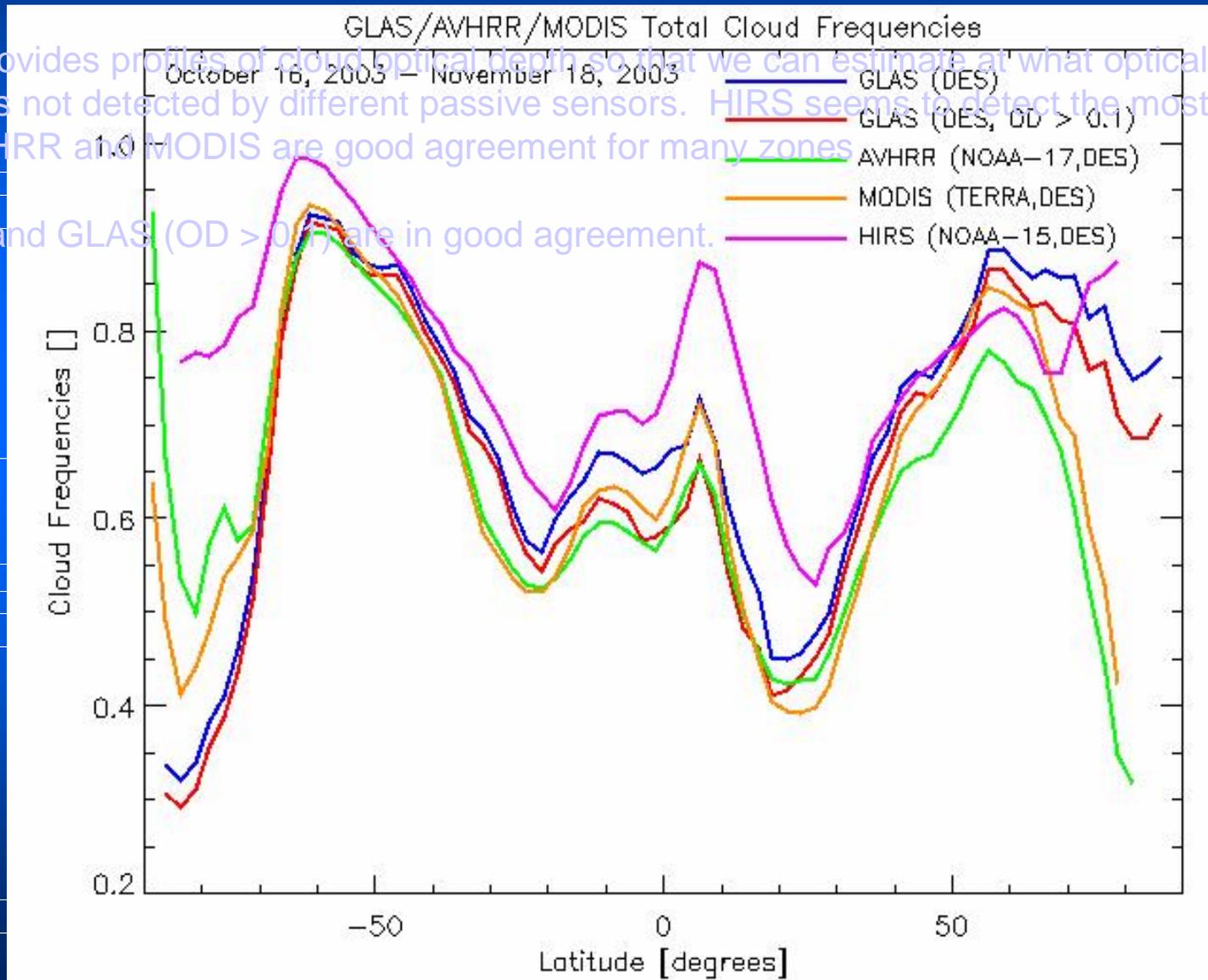
We actively seek guidance from the MODIS Team to help make the AVHRR/MODIS cloud climate records continuous.

Comparison of Total Cloud Amounts

- Having “tuned” the CLAVR-x cloud fraction weights to the MODIS 250 m results, we can compare the AVHRR Total Cloud Amounts to those from MODIS, HIRS and GLAS (a LIDAR).

- GLAS provides profiles of cloud optical depth so that we can estimate at what optical depth are clouds not detected by different passive sensors. HIRS seems to detect the most cloud while AVHRR and MODIS are in good agreement for many zones.

- MODIS and GLAS (OD > 0.1) are in good agreement.

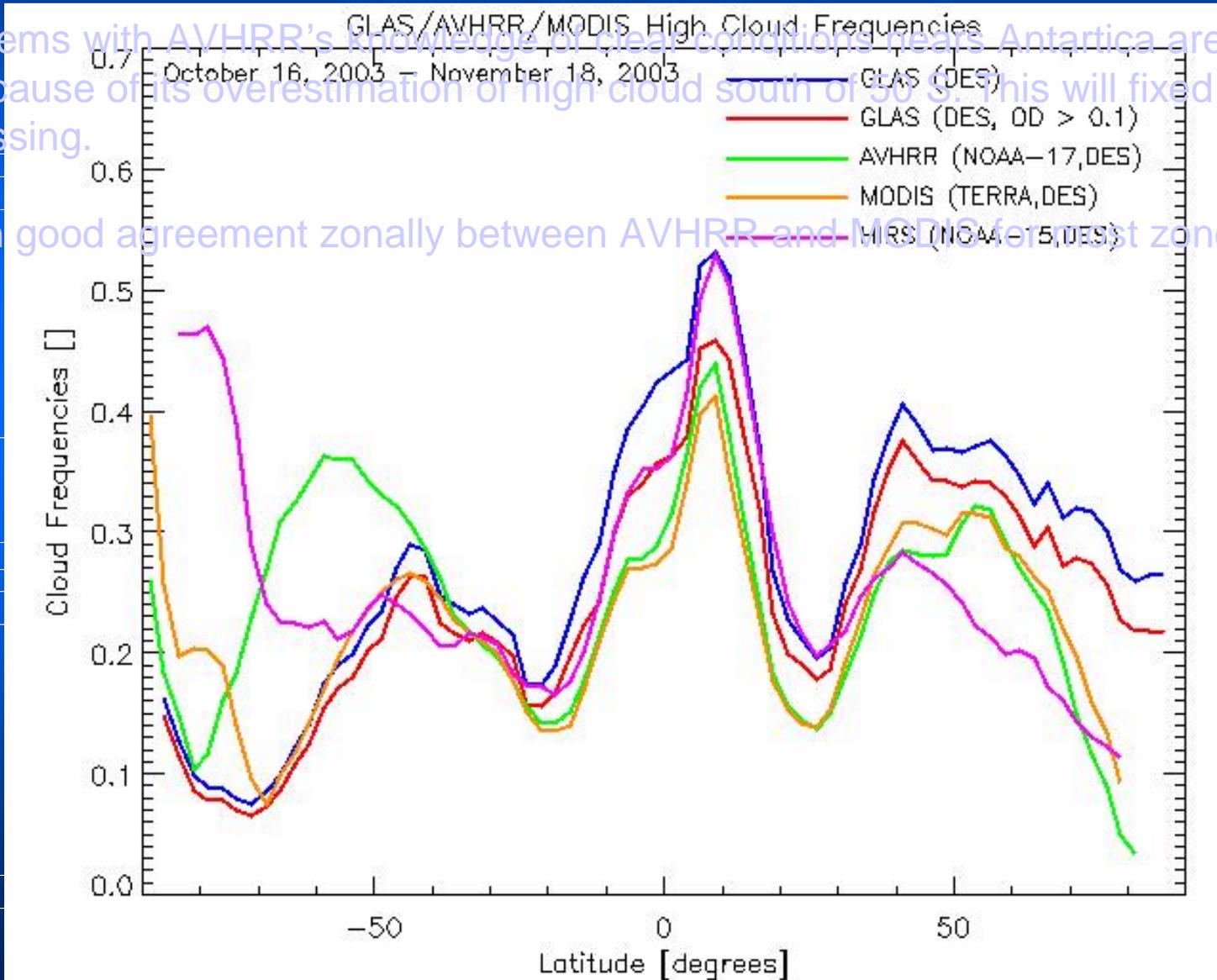


Comparison of High Cloud Amounts

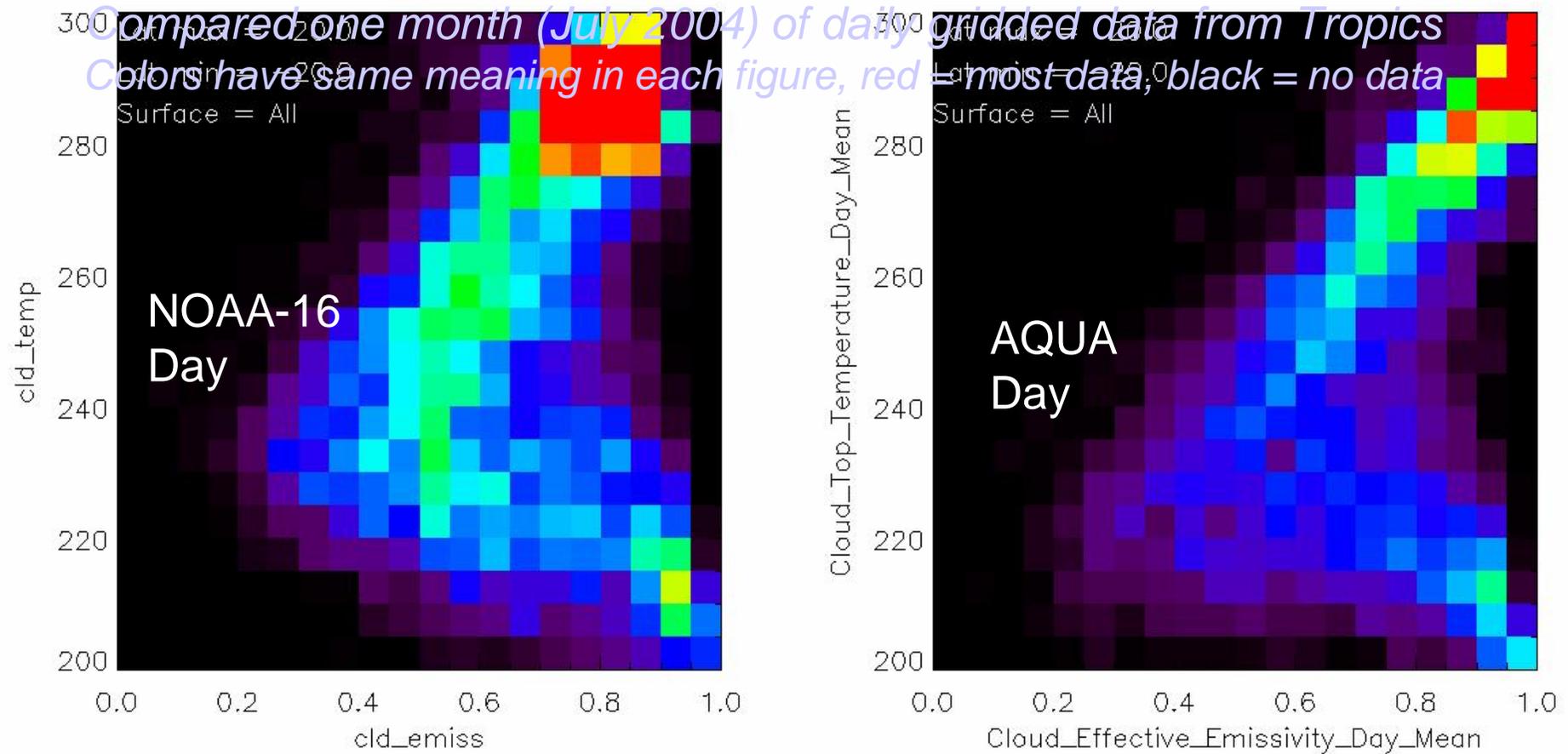
- GLAS high cloud amounts are determined as clouds above 7000m while AVHRR, HIRS and MODIS use a 440 hPa pressure threshold.

• Problems with AVHRR's knowledge of clear conditions nears Antarctica are the likely cause of its overestimation of high cloud south of 50° S. This will be fixed in future processing.

• Again good agreement zonally between AVHRR and MODIS for most zones



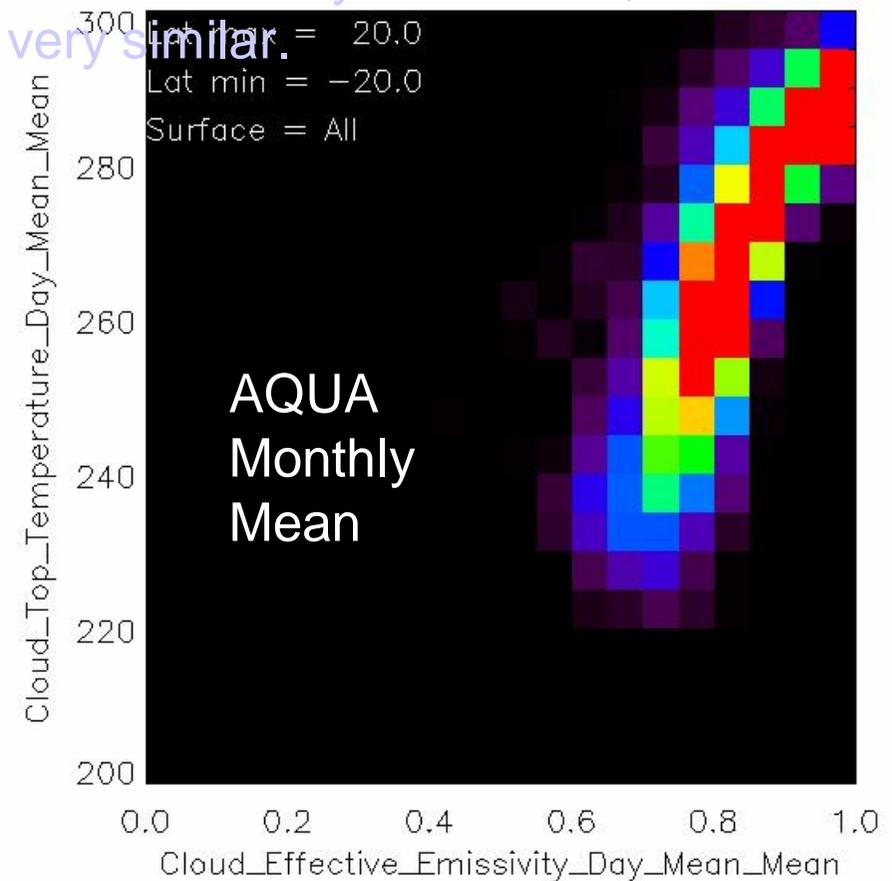
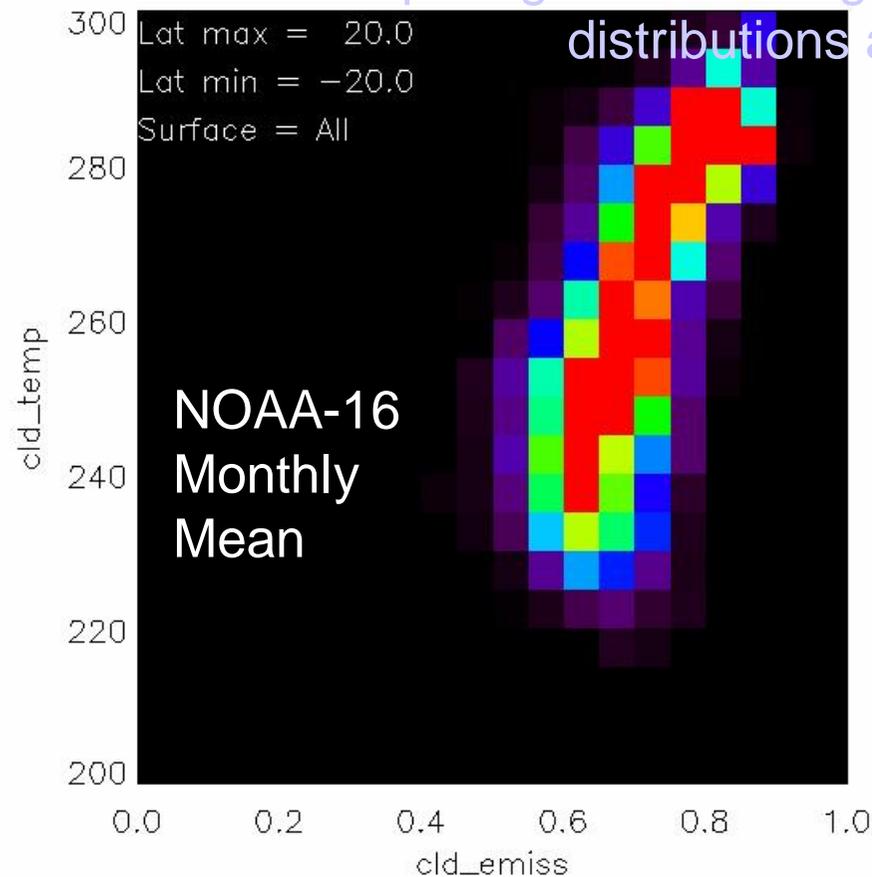
2D Histograms of MODIS (MOD06) and AVHRR (CLAVR-x) Cloud Top Temperature and Emissivity



- MODIS appears to have colder clouds with lower emissivities – an expected consequence of the ability to do co2 slicing as opposed to the more limited split-window approach used in the AVHRR.
- Does not appear to dramatically effect high cloud amount comparisons.

2D Histograms of AQUA (MOD06) and AVHRR (NOAA-16) Cloud Top Temperature and Emissivity

When comparing the 2d histograms from monthly mean data, the distributions are very similar.

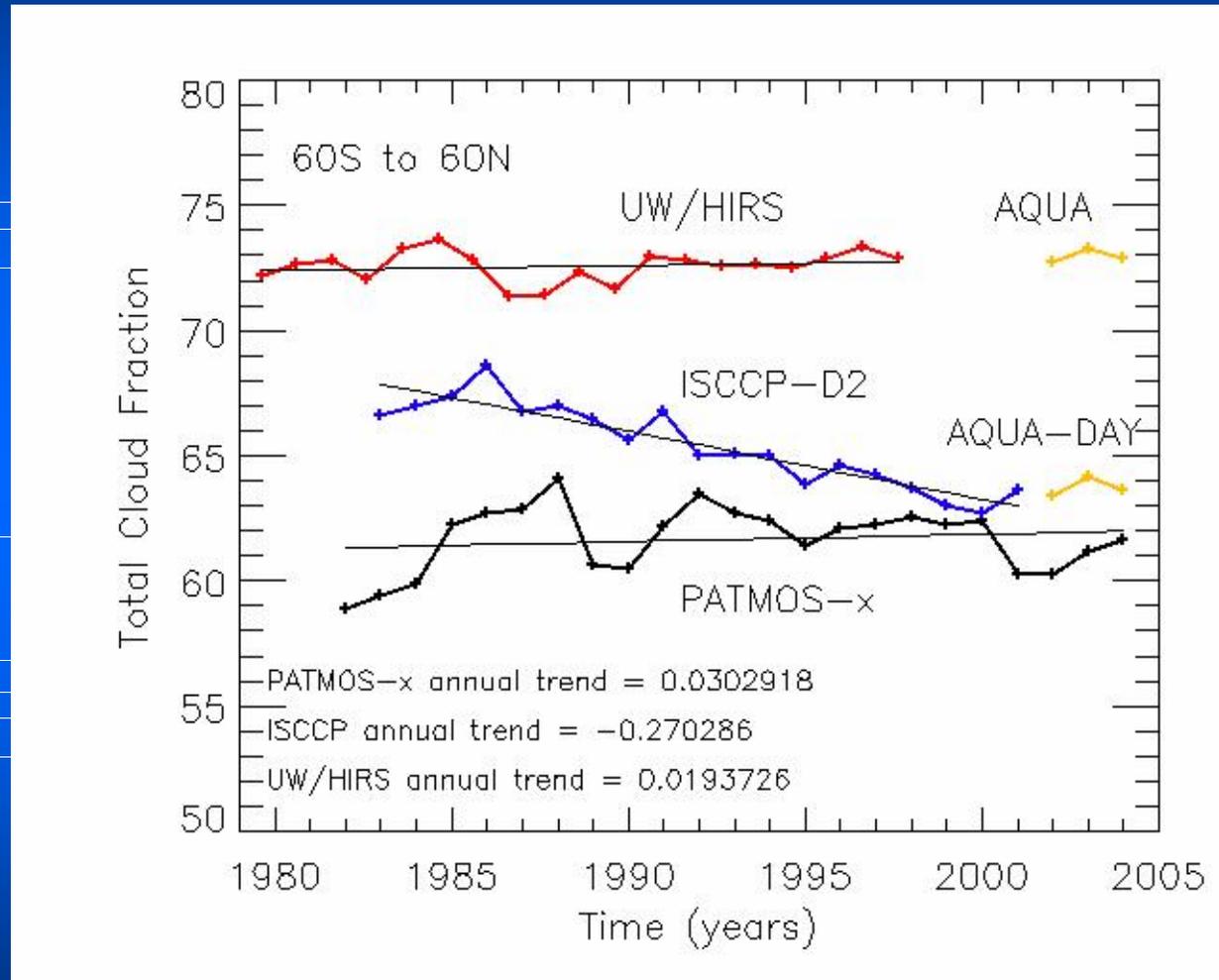


We will try and make Level 3 products that are comparable to MODIS.

Long Term Trends in Cloud Amount (Total Cloud)

This comparison shows the yearly variation in the mean July Total Cloud Amount in the Tropics.

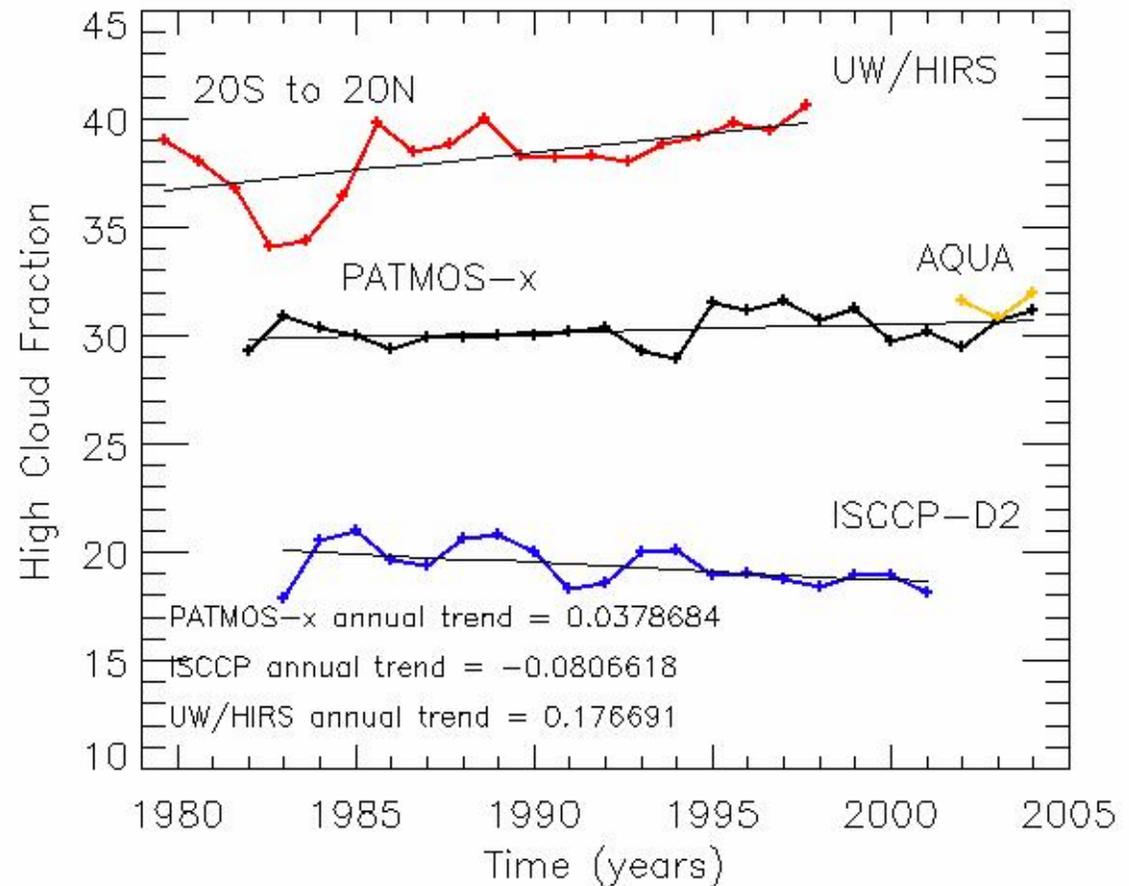
- HIRS and PATMOS-x show little trend compared to ISCCP-D2.
- AQUA shows a large difference between its daytime value and daily averaged value. Will be reduced in V5.
- Some features in PATMOS-x attributable to AVHRR to AVHRR differences. (1.6 vs 3.75 μm channel)



Long Term Trends in Cloud Amount (High Cloud)

This comparison shows the yearly variation in the mean July High Cloud Amount in the Tropics.

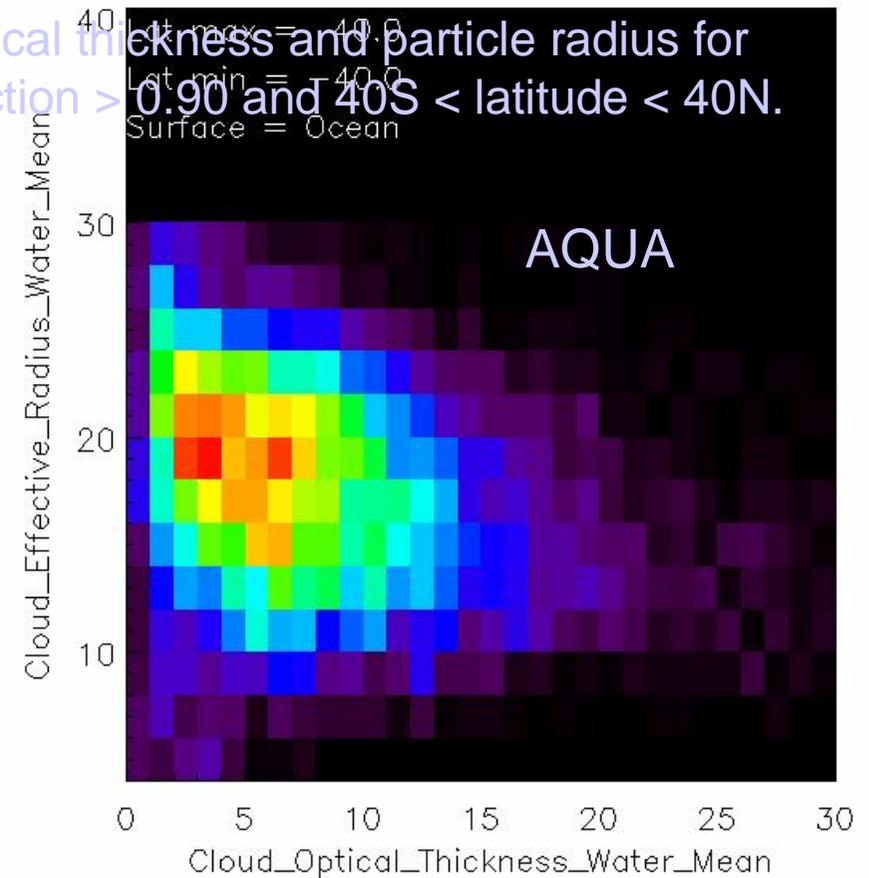
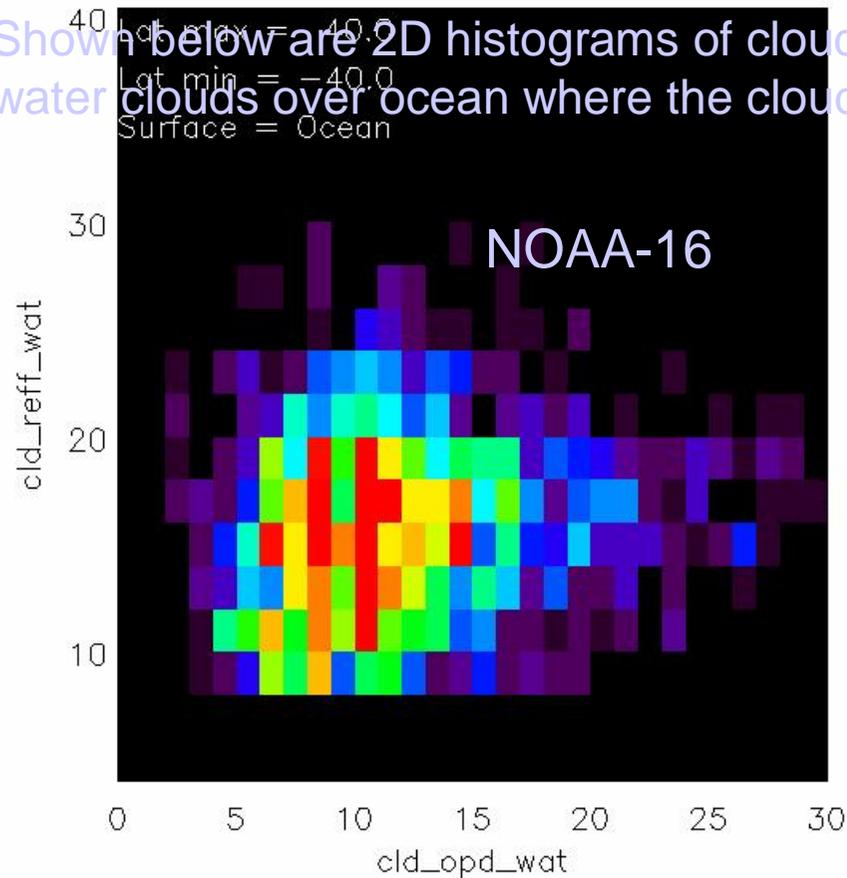
- AQUA and PATMOS-x agree in magnitude.
- ISCCP-D2 daily value suffers from poor night-time performance.
- HIRS shows a slight positive trend while PATMOS-x shows no trend and ISCCP-D2 shows a very small negative trend.



Comparison of Other Properties (Cloud Optical Thickness and Particle Size)

In addition to cloud amounts and heights, we are comparing other AVHRR cloud properties to those from MODIS.

Shown below are 2D histograms of cloud optical thickness and particle radius for water clouds over ocean where the cloud fraction > 0.90 and 40S < latitude < 40N.



We think water clouds over the ice-free ocean is one scenario where AVHRR can agree with MODIS. We have just started to pursue consistency for these properties.

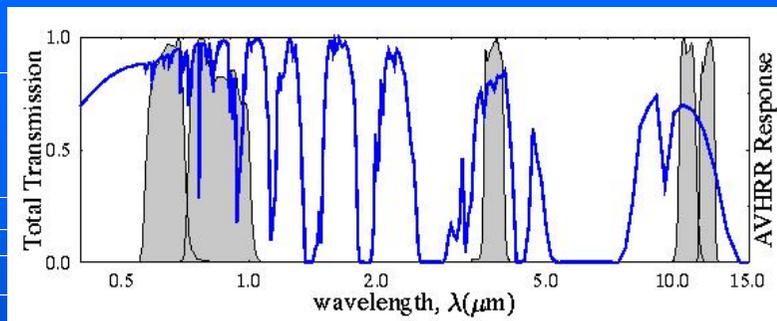
Conclusions

- ORA is working to improve the quality the AVHRR data-record.
- We continue to try and achieve physical consistency for selected climate data records between MODIS and AVHRR. This will allow us to use MODIS to connect POES with NPOESS (VIIRS) climate records.
- The total cloud amount time series from UW/HIRS, ISCCP-D2 and PATMOS-x differ in magnitude and in the long term trends. We suspect that MODIS Version 5 data will lie between UW/HIRS and PATMOS-x/ISCCP.
- MODIS high cloud amounts in the Tropics appear to be in rough agreement with that the 24 years of AVHRR data.
- Analysis of the 2d Histograms of MODIS and AVHRR Cloud Temperature and Emissivities indicate that MODIS is tending to place optically thin cloud at colder temperatures – an expected outcome. Does not appear to hurt high cloud comparisons.
- We seek any involvement from the MODIS team who are interested in the AVHRR/MODIS/VIIRS continuity of cloud climate records. This includes all cloud parameters (optical depths, particle sizes and cloud types).

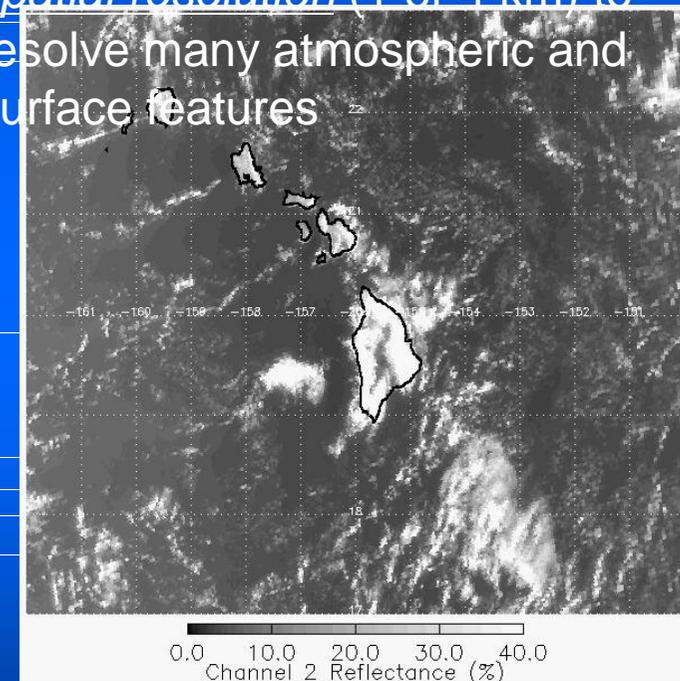
ORA's AVHRR Reprocessing Project

The Advanced Very High Resolution Radiometer (AVHRR) was launched in the 1979 for non-quantitative cloud imagery and SST. It flies on the NOAA Polar Orbiting Satellites (POES)

1. AVHRR Provides enough spectral information for several applications



2. AVHRR provides enough spatial resolution (1 or 4 km) to resolve many atmospheric and surface features



3. Combined with its long data record (1979-2012) make the AVHRR data-set appealing for decadal climate studies